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SPECIFICATION

MUSCLE STRENGTH INCREASING SYSTEM AND COMPRESSION PRESSURE CONTROL UNIT FOR MUSCLE STRENGTH INCREASING DEVICE

TECHNICAL FIELD

The present invention relates to system and device for use in muscle development. More particularly, the present invention relates to muscle strength development system and device suitable for a pressure muscle training method that allows healthy people as well as people having motor abnormalities to increase their muscle strength in an effective manner.

BACKGROUND ART

The present inventor has conducted studies for some time in order to work out a muscle training method for easy, safe, and effective muscle development, and put together the accomplishments into a patent application having Japanese Patent Application No. 5-313949, which has been granted as Japanese Patent No. 2670421.

The muscle training method according to the subject patent, which involves the application of pressure, was a distinctive non-conventional one called a "Pressure Muscle Training Method". This muscle training method is based on the following theoretical concept.

Muscles are composed of slow-twitch muscle fibers and fast-twitch muscle fibers. Slow-twitch muscle fibers are limited in their potential for growth. Accordingly, it is necessary to recruit fast-twitch muscle fibers of the slow- and fast-twitch muscle fibers in order to develop muscles. Recruitment of

fast-twitch muscle fibers causes lactic acid buildup in the muscles, which triggers secretion of growth hormone from the pituitary. The growth hormone has effects of, for example, promoting muscle growth and shedding body fat. This means that recruitment of fast-twitch muscle fibers results in development of fast-twitch muscle fibers and, in turn, the entire muscles.

Slow-twitch muscle fibers and fast-twitch muscle fibers are different from each other in terms of the following. Slow-twitch muscle fibers use oxygen for energy and are recruited for low-intensity activities. Fast-twitch muscle fibers provide for activities regardless of whether or not oxygen is present. They are recruited after the slow-twitch muscle fibers for highly intense activities. Therefore, it is necessary to cause the earlier activated slow-twitch muscle fibers to be exhausted soon in order to recruit fast-twitch muscle fibers.

Conventional muscle strength increasing methods use heavy exercises with, for example, a barbell to cause the slow-twitch muscle fibers to be exhausted first, and then to recruit the fast-twitch muscle fibers. This recruitment of the fast-twitch muscle fibers requires a significant amount of exercises, is time-consuming, and tends to increase the burden on muscles and joints.

Conventional muscle training methods use exercises with, for example, a barbell to cause the slow-twitch muscle fibers to be exhausted first, and then to recruit the fast-twitch muscle fibers. This requires a significant amount of exercises, is time-consuming, and tends to increase the burden on muscles and joints.

On the other hand, when a predetermined range of muscles is pressurized to restrict the blood flow therethrough before muscle

exercises, less oxygen is supplied to these muscles. The slow-twitch muscle fibers, which require oxygen for energy, are thus exhausted in a short period of time. Muscle exercises with blood-flow restriction by application of pressure will result in recruitment of the fast-twitch muscle fibers without needing a large amount of exercises.

In addition, restriction of the blood flow by application of pressure makes the lactic acid built up in the muscles less likely to be removed from the muscles. Thus, the muscle lactic acid level is more likely to rise and a much larger amount of growth hormone is secreted, as compared with the case where the blood flow is unrestricted.

Based on this theoretical concept, restriction of the muscle blood flow can provide significant development of the muscles.

The pressure muscle training method according to the aforementioned patent is premised on the theoretical concept of muscle strength increase by the restriction of blood flow. More specifically, a compression force for the blood flow restriction is applied to a range near the muscles that you want to develop and closer to the heart, i.e., a proximal region near those muscles. The compression force is controlled to put an appropriate stress attributed to blood flow decrease on the muscles, thereby causing muscle fatigue. Thus, effective muscle development is achieved.

This muscle training method features in muscle development without any exercises because it involves developing muscles by putting a stress attributed to blood flow decrease on the muscles. In addition, this muscle training method can compensate for a total amount of stress that is placed on the muscles by putting a stress attributed to blood flow decrease on the muscles. When combined

with some exercises, the method advantageously reduces an exercise-related stress as compared with conventional methods. This advantage brings about some effects: the possibility of incurring damages to the joints or muscles can be reduced and the period of training can be reduced, as a result of decrease in amount of muscle exercises.

The present inventor invented a tight fitting band that restricts the blood flow using a compression force produced by a belt, which is disclosed in the aforementioned Japanese Patent Application No. 5-313949, as an implement that can put a stress on muscles by restricting the blood flow through the muscles, thereby achieving muscle development.

However, such a muscle strength increasing device also has a challenge to be solved.

More specifically, in order to practice the pressure muscle training method in a more effective and safe manner, it is necessary to manage the compression force or the compression pressure applied to the muscles. In general, the wearer of the muscle strength increasing device or a person who has advance knowledge about the muscle training method applies a compression pressure that is optimum for the muscles of the person who uses the pressure muscle training method to manage the compression pressure and the compression duration.

However, this management is difficult for those having no advanced knowledge. In addition, to practice the pressure muscle training method should have a trouble if it can be used only under the control of a person who has advanced knowledge. Furthermore, when the aforementioned management is performed by the wearer himself or herself, this causes an extra effort for the wearer who

uses the pressure muscle training method. He or she cannot concentrate the training or rehabilitation to develop his or her muscles, which may sometimes prevent efficient training.

On the other hand, the pressure muscle training method features that muscles are developed without any exercises only by means of applying a pressure thereto and is thus expected to find applications in rehabilitation. However, an action to do the aforementioned management itself may be a burden for those who have motor abnormalities or those requiring rehabilitation. It is better if this point is improved when the pressure muscle training method is practiced in the rehabilitation fields.

Therefore, an object of the present invention is to provide a technique with which the pressure muscle training method can be used effectively and safely by a person who has no special advanced knowledge.

SUMMARY OF THE INVENTION

In order to achieve the aforementioned object, the present invention provides a muscle strength increasing system used for developing muscles of at least one of the limbs of a wearer while restricting the blood flow therethrough by means of applying a predetermined compression pressure to the limb, the muscle strength increasing system comprising a muscle strength increasing device having a compressing member for tightening and compressing muscles and a compression pressure controller for controlling said compression pressure, said compression pressure controller being configured to control said compression pressure so that it does not exceed a preset critical compression pressure.

As described above, in this muscle strength increasing system,

the compression pressure controller automatically controls the compression pressure. Therefore, people having no special technical knowledge as well as people having motor abnormalities can use the pressure muscle training method without having to worry about the details of the compression pressure.

In addition, since the compression pressure controller in the muscle strength increasing system controls the compression pressure so that it does not exceed a preset critical compression pressure, the pressure muscle training method can be practiced in a safe manner by setting the critical compression pressure within a safe range of the compression pressure for the wearer.

The muscle strength increasing device in the present invention is used to develop muscles of at least one of the limbs of a wearer while restricting the blood flow therethrough by means of applying a predetermined compression pressure to the limb. It may have any specific configuration as long as it has a compressing member that tightens and compresses muscles. For example, the muscle strength increasing device may comprise a hollow tight fitting band having a tube therein to which the air is to be supplied with a predetermined pump, and fastening means for use in keeping a length of said tight fitting band in a loop having a desired size.

Any compression pressure controller may be used in the present invention as long as it can control the compression pressure applied to muscles of the wearer by the muscle strength increasing device. When the muscle strength increasing device comprises the tight fitting band and the fastening means as described above, the compression pressure controller may be adapted to control said compression pressure based on the air pressure within said tube which is measured by the pressure gauge for measuring the air

pressure within the tube, included in the muscle strength increasing device.

Furthermore, said compression pressure controller of the present invention may have setting means which can set the maximum value of said compression pressure at a desired pressure and said setting means may be configured to set the maximum value of said compression pressure without exceeding said critical compression pressure. This allows the wearer to set the compression pressure, so that the compression pressure can be set depending to some extent on the preference and need of the wearer. In addition, the maximum value of the compression pressure that is set then is controlled not to exceed said critical compression pressure, so that the safety in practicing the pressure muscle training method can be improved.

It should be noted that, in this case, the critical compression pressure should be permitted to be set only by a person who has an authorization to do so (e.g., a person who has knowledge about training, such as a trainer and a physician). For example, an input device for the input to the compression pressure controller is kept available for a person having the authorization, or the muscle strength increasing system is provided with means for authentication before the input to the compression pressure controller and an ID or a password required for the authentication is given only to a person having the authorization, or a recording medium, such as an IC card, having the data required for the authentication thereon is given only to a person having the authorization. This permits only the person having the authorization to set the critical compression pressure. As specific means for them, those similar to the one described below in the compression pressure control unit may be used.

In addition, the present invention also provides a muscle strength increasing system used for developing muscles of at least one of the limbs of a wearer while restricting the blood flow therethrough by means of applying a predetermined compression pressure to said limb, the muscle strength increasing system comprising a muscle strength increasing device having a compressing member for tightening and compressing muscles and a compression pressure controller for controlling said compression pressure, said compression pressure controller being configured to control said compression pressure so that the time interval during which said compression pressure is applied to the wearer falls within a range that does not exceed a preset critical compression duration.

In this muscle strength increasing system, the compression pressure controller automatically controls the compression pressure. Therefore, people having no special technical knowledge as well as people having motor abnormalities can use the pressure muscle training method without having to worry about the details of the compression pressure.

In addition, the compression pressure controller in the muscle strength increasing system controls the time interval during which the compression pressure is applied to the wearer so that it does not exceed the preset critical compression duration. Therefore, the pressure muscle training method can be practiced in a safe manner by setting the critical compression duration within a safe range of the compression time interval for the wearer.

The compression pressure controller of the present invention may have time counting means for measuring time during which said compression pressure is applied, said compresson pressure contoroller being adapted to reduce said compression pressure

when the time measured by the time counting means exceeds a predetermined time interval. This prevents the time interval during which the compression pressure is applied from becoming excessive, so that the pressure muscle training method can be practiced in a safe manner.

The compression pressure controller of the present invention may have setting means with which said predetermined time interval can be set at a desired time interval. In addition, said predetermined time interval that is set by said setting means in this case may be determined not to exceed a predetermined setting time interval.

This allows the wearer to set the time interval during which the compression pressure is kept, so that the time interval during which the compression pressure is applied can be set depending to some extent on the preference and need of the wearer. In addition, the aforementioned predetermined time interval that is set then is controlled not to exceed a predetermined set time interval, so that the safety in practicing the pressure muscle training method can be improved when only a person who has knowledge about the training, such as a physician, is permitted to have the authorization of setting the set time interval.

It should be noted that, in this case, the set time is permitted to be set only by the person who has an authorization to do setting. As specific aspects thereof, the aforementioned technique may be used that permits only the person having the authorization to set the critical compression pressure. As specific means for them, those similar to the one described below in the compression pressure control unit may be used.

In addition, the present invention also provides a muscle

strength increasing system used for developing muscles of at least one of the limbs of a wearer while restricting the blood flow therethrough by means of applying a predetermined compression pressure to said limb, the muscle strength increasing system comprising a muscle strength increasing device having a compressing member for tightening and compressing muscles and a compression pressure controller for controlling the compression pressure, said compression pressure controller being configured to control said compression pressure and/or the time interval during which said compression pressure is applied to said limbs.

As apparent from the above, automatic control of the compression pressure and the time interval during which it is applied to the limb(s) eliminates the necessity for the wearer to control the compression pressure and the time for training, providing efficient muscle development.

In addition, the present invention also provides a compression pressure control unit of a muscle strength increasing device for controlling a predetermined compression pressure used for developing muscles of at least one of the limbs of a wearer while restricting the blood flow therethrough by means of applying said compression pressure to said limb, the compression pressure control unit having a compressing member tightening and compressing muscles, the compression pressure control unit being configured to control said compression pressure so that it does not exceed a preset critical compression pressure.

This compression pressure control unit automatically controls the compression pressure. Therefore, it provides an effect that people having no special technical knowledge as well as people having motor abnormalities can use the pressure muscle

training method without having to worry about the details of the compression pressure, and an effect that, since the compression pressure is controlled so that it does not exceed a preset critical compression pressure, the pressure muscle training method can be practiced in a safe manner by setting the critical compression pressure within a safe range of the compression pressure for the wearer.

The compression pressure control unit of the present invention may comprise first recording means on which said critical compression pressure is recorded and may be for controlling said compression pressure based on said critical compression pressure recorded on the first recording means.

The compression pressure control unit may also comprise predetermined first input means for supplying said critical compression pressure to said first recording means through its operation. Such first input means allows for a variable critical compression pressure and different critical compression pressures to be set for individual wearers. In addition, it is easier to manage a change of the wearer or a change in health condition of the wearer.

The compression pressure control unit of the present invention may comprise second recording means on which the maximum value of said compression pressure is recorded and may be for controlling said compression pressure based on the maximum value of said compression pressure recorded on the second recording means.

In addition, the compression pressure control unit may comprise predetermined second input means for supplying the maximum value of said compression pressure to said second recording means

through its operation, and the maximum value of said compression pressure recorded on said second recording means may be controlled not to exceed said critical compression pressure.

This allows for a variable maximum value of the compression pressure and, consequently, the maximum value of the compression pressure can be set depending to some extent on the preference and need of the wearer. In addition, the maximum value of the compression pressure that is modified here is controlled not to exceed the aforementioned critical compression pressure. Accordingly, this compression pressure control unit also ensures high safety of the pressure muscle training method.

The aforementioned compression pressure control unit may comprise a main body having said second recording means. Said first input means may freely be attached to and removed from said main body. In this case, when the first input means is kept available for a person having the authorization as described above, the critical compression pressure can be set only by the person having such authorization. This ensures the safety of the pressure muscle training method.

The aforementioned compression pressure control unit may comprise authentication means for determining whether or not an input from said first input means is allowed, wherein the input from said first input means is accepted only when said authentication means performs authentication indicating that the input is permitted. In situations where only the person having the authorization as described above can be authenticated, the critical compression pressure can be set only by the person having such authorization. This also ensures the safety of the pressure muscle training method. The authentication means in such a case

may comprise an authentication operator for entering data for authentication, and decision means for determining whether the data for authentication received from the authentication operator are valid, and said authentication may be made when said authentication means determines that said data for authentication are valid. The data for authentication in this case is, for example, an ID or a password assigned only to the person having the authorization as described above. Furthermore, the authentication means may comprise reading means for reading data for authentication from a predetermined recording medium, and decision means for determining whether said data for authentication read by the reading means are valid, and said authentication may be made when said authentication means determines that said data for authentication are valid. The recording medium in this case is, for example, a magnetic card and an IC card.

Furthermore, the present invention also provides a compression pressure control unit of a muscle strength increasing device for controlling a predetermined compression pressure used for developing muscles of at least one of the limbs of a wearer while restricting the blood flow therethrough by means of applying said compression pressure to the limb, the compression pressure control unit having a compressing member tightening and compressing muscles, the compression pressure control unit being configured to control said compression pressure so that the time interval during which said compression pressure is applied to the wearer falls within a range that does not exceed a preset critical compression duration.

This compression pressure control unit automatically controls the compression pressure. Therefore, it provides an

effect that people having no special technical knowledge as well as people having motor abnormalities can use the pressure muscle training method without having to worry about the details of the compression pressure, and an effect that, since the time interval during which the compression pressure is applied to the wearer is controlled so that it does not exceed the preset critical compression duration, the pressure muscle training method can be practiced in a safe manner by setting the critical compression duration within a safe range of the compression time for the wearer.

This compression pressure control unit may comprise third recording means on which said critical compression duration is recorded, and the compression pressure control unit may be for controlling said compression pressure based on the critical compression duration recorded on the third recording means. In addition, the compression pressure control unit may comprise predetermined third input means for entering said critical compression duration to said third recording means through its operation. Such third input means allows for a variable critical compression duration and different critical compression durations to be set for individual wearers. In addition, it is easier to manage a change of the wearer or a change in health condition of the wearer.

Furthermore, this compression pressure control unit may comprise fourth recording means on which the maximum value of a time interval during which said compression pressure is applied to the wearer is recorded, and the compression pressure control unit may be for controlling said compression pressure based on the maximum value of the time interval during which said compression pressure is applied to the wearer, which is recorded on the fourth

recording means.

In addition, the compression pressure control unit may comprise predetermined fourth input means for entering said maximum value of the time interval during which said compression pressure is applied to the wearer, to said fourth recording means through its operation, and said maximum value of the time interval during which said compression pressure is applied to the wearer, which is recorded on said fourth recording means, may be controlled not to exceed said critical compression duration. This allows for a variable maximum value of the compression duration. Thus, the maximum value of the compression duration can be set depending to some extent on the preference and need of the wearer. The maximum value of the compression duration that is modified here is controlled not to exceed the aforementioned critical compression duration. Accordingly, this compression pressure control unit also ensures high safety of the pressure muscle training method.

This compression pressure control unit may also comprise a main body having said fourth recording means. In addition, said third input means may freely be attached to and removed from said main body. In this case, when the third input means is kept available for a person having the authorization as described above, the critical compression duration can be set only by the person having such authorization. This ensures the safety of the pressure muscle training method.

The aforementioned compression pressure control unit may also comprise authentication means for determining whether or not an input from said third input means is allowed, wherein the input from said third input means is accepted only when said authentication means performs authentication indicating that the

input is permitted. In situations where only the person having the authorization as described above can be authenticated, the critical compression pressure can be set only by the person having such authorization. This also ensures the safety of the pressure muscle training method. The authentication means in such a case may comprise an authentication operator for entering data for authentication, and decision means for determining whether the data for authentication received from the authentication operator are valid, and said authentication may be made when said authentication means determines that said data for authentication are valid. The data for authentication in this case is, for example, an ID or a password assigned only to the person having the authorization as described above. In addition, the authentication means may comprise reading means for reading data for authentication from a predetermined recording medium, and decision means for determining whether said data for authentication read by the reading means are valid, and said authentication may be made when said authentication means determines that said data for authentication are valid. The recording medium in this case is, for example, a magnetic card and an IC card.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view including a partially schematic view showing the entire configuration of a pressure muscle strength increasing system according to the first embodiment;

Fig. 2 is a cross-sectional view of a muscle strength increasing device included in the pressure muscle strength increasing system shown in Fig. 1;

Fig. 3A is a view showing a clip in the muscle strength

increasing device included in the pressure muscle strength increasing system shown in Fig. 1, while Fig. 3B is a view illustrating how the clip is attached to the muscle strength increasing device;

Fig. 4 is a hardware configuration of a control mechanism included in the pressure muscle strength increasing system shown in Fig. 1;

Fig. 5A is a view showing an operation panel provided on the outer surface of a compression pressure control unit included in the pressure muscle strength increasing system shown in Fig. 1, while Fig. 5B is an enlarged view of an exemplified image displayed on a display unit provided on the operation panel;

Fig. 6 is a block diagram showing a functional block to be generated within the control mechanism in the pressure muscle strength increasing system shown in Fig. 1;

Fig. 7 is a perspective view illustrating how the muscle strength increasing device in the pressure muscle strength increasing system shown in Fig. 1 is used;

Fig. 8 is a flow diagram illustrating a process flow to be carried out by the compression pressure control unit in the pressure muscle strength increasing system shown in Fig. 1;

Fig. 9 is a flow diagram illustrating a process flow to be carried out by the compression pressure control unit in the pressure muscle strength increasing system shown in Fig. 1, in a stand-by mode shown in Fig. 8;

Fig. 10A is a view describing parameters to be used in the compression pressure control unit in the pressure muscle strength increasing system shown in Fig. 1, while Fig. 10B is a view illustrating an available range for each parameter;

Fig. 11A is a view showing a compression sequence used when the pressure muscle strength increasing system shown in Fig. 1 operates in a rehabilitation control mode, while Fig. 11B is a view showing a compression sequence used when the pressure muscle strength increasing system shown in Fig. 1 operates in a training control mode;

Figs. 12A to 12E are views showing compression sequences used when a RESET button is used in the pressure muscle strength increasing system shown in Fig. 1;

Fig. 13 is a view illustrating which parameter can be designated at which stage in the operation mode carried out by the pressure muscle strength increasing system shown in Fig. 1;

Fig. 14A is a horizontal cross-sectional view of an outer fabric of a tight fitting band according to a modified embodiment in which a wire-like piece is used in place of a limit piece of the muscle strength increasing device, while Fig. 14B is a vertical cross-sectional view of the outer fabric of the tight fitting band;

Fig. 15 is a cross-sectional view of a tight fitting band according to another modified embodiment, in which a wire-like piece is used in place of a limit piece of the muscle strength increasing device;

Fig. 16 is a cross-sectional view of a muscle strength increasing device according to another modified embodiment;

Fig. 17 is a cross-sectional view of a muscle strength increasing device according to another modified embodiment;

Fig. 18 is a cross-sectional view of a muscle strength increasing device according to another modified embodiment;

Fig. 19 is a view showing a remote controller included in the pressure muscle strength increasing system shown in Fig. 1;

Fig. 20 is a view showing an operation panel provided on the outer surface of the compression pressure control unit included in a pressure muscle strength increasing system according to a second embodiment;

Fig. 21 is a block diagram showing a functional block to be generated within the control mechanism in the pressure muscle strength increasing system according to the second embodiment;

Fig. 22 is a flow diagram illustrating a process flow to be carried out by the compression pressure control unit in the pressure muscle strength increasing system according to the second embodiment, in a stand-by mode;

Fig. 23 is a view showing an operation panel provided on the outer surface of the compression pressure control unit included in a pressure muscle strength increasing system according to a third embodiment;

Fig. 24 is a block diagram showing a functional block to be generated within the control mechanism in the pressure muscle strength increasing system according to the third embodiment; and

Fig. 25 is a flow diagram illustrating a process flow to be carried out by the compression pressure control unit in the pressure muscle strength increasing system according to the third embodiment, in a stand-by mode.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring to the drawings, first through third embodiments of the present invention are described. In the following description of the embodiments, similar components and parts are depicted by the like reference numerals, and any redundant description will be omitted.

<<First Embodiment>>

Fig. 1 is a view showing a first embodiment of a pressure muscle strength increasing system according to the present invention. This pressure muscle strength increasing system includes a muscle strength increasing device 10 and a compression pressure control unit 20. They are connected to each other through a connection member 4.

The muscle strength increasing device 10 in this embodiment is configured as shown in Figs. 1 and 2. Fig. 2 is a cross-sectional view of the muscle strength increasing device 10 according to this embodiment.

The muscle strength increasing device 10 comprises a belt-shaped tight fitting band 1 that has a space inside it. The tight fitting band 1 is made up of two pieces of heavy fabric having a width of on the order of 5 cm. These pieces are stitched together along the lengthwise edges to form a long hollow object having a space inside it. The fabric used on the side facing to muscles (inner side) of the tight fitting band 1 is made of stretch threads woven together to have a net-like appearance.

The tight fitting band 1 has a tube 5 therein. The tube 5 is made of a rubber that can withstand a pneumatic pressure of on the order of 300 mmHg.

The muscle strength increasing device 10 according to this embodiment further comprises a clip 12 as shown in Fig. 3A for delimiting the portion of the tube 5 into which air is introduced when attached to the tight fitting band 1 at a certain position along the length thereof.

The clip 12 has a shape of hairpin having two parallel straight

segments and another segment connecting the one end of these two straight segments with each other. The length of the straight segment of the clip 12 is generally identical to the width of the tube 5. The distance between the straight segments is generally identical to the thickness of the tube 5. When used, the clip 12 is attached to the tube 5 in the widthwise direction of the tube in such a manner that the clip pinches the tube 5 as shown in Fig. 3B. This can delimit the range into which the air is introduced (the range inflated by the incoming air) of the tube 5 in the direction along the length of the tube.

The tight fitting band 1 has a limit piece 6 therein along the outer contour of the tube 5. The limit piece 6 is a plate-like object having a width of about 4 cm that is made of a polypropylene resin.

A fixing unit 7 is provided on the outer surface of the tight fitting band 1. The fixing unit 7 is for holding in place the tight fitting band 1 that is fitted around the tightened area of the wearer. The fixing unit 7 in this embodiment is a Velcro tape.

The connection member 4 in this embodiment is made up of connecting pipes 8a, 8b, and 8c and a T-shaped pipe 9 (Fig. 1). It should be noted that the connecting pipes 8b and 8c as well as the T-shaped pipe 9 are provided inside the compression pressure control unit 20. In addition, each of the connecting pipes 8a, 8b, and 8c is, but not limited to, a rubber tube and the T-shaped pipe 9 is made of a resin in this embodiment. The connecting pipe 8a can be attached to and removed from the T-shaped pipe 9.

It should be noted that while Fig. 1 illustrates only one muscle strength increasing device 10, the compression pressure control unit 20 in practice is connected to two muscle strength

increasing devices 10 designed for both right and left arms. The two muscle strength increasing devices 10 designed for the right and left arms are identical to each other, so that only one of them is shown in Fig. 1 and illustration of the other is omitted.

It is apparent that the muscle strength increasing devices 10 are not limited to those designed for the right and left arms. They may be two muscle strength increasing devices designed for the right and left legs or a combination of four muscle strength increasing devices designed for the two arms and two legs. If the Pressure Muscle Training Method is applied to two or more persons for some reasons, the muscle strength increasing device 10 of the number larger than that described above may be connected to the compression pressure control unit 20. This indicates that the number of the muscle strength increasing devices 10 may be determined arbitrarily within the range of at least 1, when necessary.

The compression pressure control unit 20 is for controlling the muscle strength increasing device 10.

The compression pressure control unit 20 in this embodiment is configured with various parts and components provided inside and outside a casing.

The compression pressure control unit 20 has a pump 2, a pressure gauge 3, and a control mechanism 50 that are provided inside it as shown by broken lines in Fig. 1. The control mechanism 50 in this embodiment may be electrically (but not limited thereto) connected to the pump 2, the pressure gauge 3 and an operation panel 56. The pump 2 and the pressure gauge 3 are connected to the tight fitting band 1 through the connecting pipes 8a, 8b, and 8c and the T-shaped pipe 9.

The compression pressure control unit 20 also has the operation panel 56 that is provided outside it as shown by a solid line in Fig. 1. The operation panel 56 has a display unit 57 and an operation section 58.

The pump 2 is for forcing the air to flow into the tube 5 within the tight fitting band 1 and sucking up the air from the tube 5. The pump 2 contains a motor that is not shown. By driving the motor, the pump can fill the tube 5 with the air or suck up the air from the tube 5. The pressure gauge 3 is for indirectly measuring the compression pressure applied to muscles by the tight fitting band 1 by means of measuring the air pressure within the tube 5. It should be noted that the compression pressure control unit 20 in this embodiment has pumps 2 for the right and left arms and pressure gauges 3 for the right and left arms. However, only one for each is illustrated in Fig. 1 because they are identical to their respective counterparts. The pump 2 and the pressure gauge 3 are provided in the same number as the maximum number of the muscle strength increasing devices 10 to be attached to the compression pressure control unit 20 in question.

The control mechanism 50 is for performing the below-described control including the control of the pump(s) 2. For example, the pump 2 is controlled by the control mechanism 50 when driven.

The operation panel 56 is shown in Fig. 5A in a simplified way.

As described above, the operation panel 56 comprises the display unit 57 and the operation section 58 as shown in Fig. 5A.

The display unit 57 in this embodiment is formed by using an LCD (liquid crystal display). It is apparent that the display

device to be used for the display unit 57 is not limited thereto. Displayed on the display unit 57 are images including, for example, a value representing an air pressure within the muscle strength increasing device 10 and a numeric value indicating the elapsed time for application of a pressure. An example of the image displayed on the display unit 57 is shown in Fig. 5B.

The operation section 58 is provided with a switch for changing modes or schedules of training, a switch that is used to turn the power supply on and off, and a switch for changing between a rehabilitation mode during which muscles are being developed while the muscle strength increasing device 10 is kept connected to the control mechanism 50 and a training control mode during which muscles are being developed after the muscle strength increasing device 10 is separated from the control mechanism 50 and other components (details of these control modes are described below). A wearer may operate, in a user mode described below, the operation section 58 to enter data about the air pressure, data about the air pressure achieved before the count-up time reaches the upper limit, and data about the count-up time. It should be noted that the operation section 58 is also provided, in addition to the aforementioned switches, with a switch for deflating the tube 5 of the muscle strength increasing device 10 in case of, for example, emergency and a switch that is used to mute a buzzing sound.

The operation section 58 has a remote controller connector 58A. The remote controller connector 58A is a terminal to which a remote controller RC shown in Fig. 19 is connected.

The remote controller RC is for supplying, to the compression pressure control unit 20, in a trainer mode described below, data about the maximum value of the air pressure (compression pressure)

(which corresponds to the critical compression pressure of the present invention)applied to the user by the compression pressure control unit 20 and data about the maximum value of a count-up time (compression duration) (which corresponds to the critical compression duration of the present invention) during which the compression pressure is applied to the user by the compression pressure control unit 20. The remote controller RC is comprised of, as shown in Fig. 19, a main body part 110 and a connecting part 120. The main body part 110 has a switch 111 that is similar to the one provided in the operation section 58 for the aforementioned inputs. The connecting part 120 is connected to the main body part 110 at one end and has a terminal 121 at the other end. The terminal 121 can be connected to the remote controller connector 58A for supplying information about operation of the switch 111 to the compression pressure control unit 20 through the remote controller connector 58A.

The wearer may operate the operation section 58 in the user mode described below to enter the maximum value of the compression pressure and the compression duration used in the pressure muscle training method to the compression pressure control unit 20. The maximum value of the compression pressure and the compression duration that are entered by the user fall within the ranges of the aforementioned maximum value of the compression pressure and the maximum value of the compression duration which have been supplied through the remote controller RC.

Fig. 4 shows a hardware configuration of the control mechanism 50. The control mechanism 50 comprises a CPU 51, an RS-232C I/F 52 (RS-232C: Recommended Standard 232 version C), an LCD I/F 53, a motor I/F 54, a pressure sensor I/F 55, the operation

section 58, and the remote controller connector 58A, all of which are connected to each other via a bus. It should be noted that the bus is also connected to a ROM on which program(s) and data are stored which are used by the CPU 51 for the execution of necessary processing and to a RAM that provides a region for the processing of the program(s).

The CPU 51 is a processing unit which executes the processing carried out by the control mechanism 50 according to the program(s) and data read out of the aforementioned ROM. The CPU 51 is adapted either to control the RS-232C I/F 52, the LCD I/F 53, the motor I/F 54, the pressure sensor I/F 55, and the operation section 58 or to receive data therefrom.

The RS-232C I/F 52 is an interface that allows data exchange with external devices (e.g., a personal computer). For example, the CPU 51 may carry out different procedures by a kind of data the RS-232C I/F 52 accepted from an external device.

The LCD I/F 53 is an interface with the display unit 57. The data generated by the CPU 51 for controlling the display unit 57 are supplied to the display unit 57 through this LCD I/F 53.

The motor I/F 54 is an interface with a motor which is not shown and which is contained in the pump 2. The data generated by the CPU 51 for controlling the motor are supplied to the display unit 57 through this motor I/F 54.

The pressure sensor I/F 55 is an interface with the pressure gauge 3. It receives the data about the air pressure measured by the pressure gauge 3. These data are sent to the CPU 51.

Fig. 6 is a view illustrating functions achieved within the control mechanism 50 when the CPU 51 executes the aforementioned program, as a functional block.

The functional block generated in the control mechanism 50 includes a pressure controller 60, a time interval controller 70, a limit value controller 80, a mode controller 90, an image generator 98, and an output controller 99.

The pressure controller 60 is for controlling the aforementioned motor within the pump 2 in order to provide an appropriate air pressure within the tube 5.

The pressure controller 60 receives the data about the air pressure from the pressure sensor I/F 55 and generates data for controlling the motor within the pump 2 based on the data.

The pressure controller 60 has a recording part which is not shown for recording, for example, data about an ideal compression pressure to be applied to the wearer by the tight fitting band 1, which is associated with the time interval from the beginning of the pressure muscle training method. It generates the data for controlling the motor in the pump 2 based on the data recorded on the recording part and the data received from the pressure sensor I/F 55. For example, the pressure controller 60 compares the data received from the pressure sensor I/F 55 with the aforementioned data about the ideal compression pressure to be applied to the wearer by the tight fitting band 1. When they are apart from each other by an amount larger than a predetermined value, then it generates data to make the data received from the pressure sensor I/F 55 to be closer to the ideal compression pressure (to drive the pump 2 to release the air from the tube 5 when the data received from the pressure sensor I/F 55 represents a higher pressure than the ideal compression pressure and drive the pump 2 to supply the air to the tube 5 when the data received from the pressure sensor I/F 55 represents a lower pressure than the ideal compression pressure).

When the aforementioned data about the ideal compression pressure is used, it becomes necessary to use the data about the ideal compression pressure at the timing when the data to drive the pump 2 is generated. Therefore, an elapsed time interval from the beginning of the pressure muscle training method should be managed. To this end, the pressure controller 60 that is going to generate data to drive the pump 2 is designed to receive the data about the aforementioned elapsed time interval from the time interval controller 70 every time when it generates the data. The pressure controller 60 in this embodiment generates the data to drive the pump 2 so that the data correspond to either one of the two control modes: rehabilitation control mode and training control mode. In order to make it possible, the pressure controller 60 receives the data about which control mode has been selected, from the mode controller 90, before the beginning of the operation mode described below. Based on these data, the pressure controller 60 generates the data for driving the pump 2 in the rehabilitation control mode or the data for driving the pump 2 in the training control mode.

The time interval controller 70 is for setting the compression duration that is used when the pressure muscle training method is performed based on the input from the operation section 58. In addition, the time interval controller 70 has a function of managing the time when the pressure muscle training method is performed. The time interval controller 70 includes a timer that measures time in order to allow it.

The limit value controller 80 is for setting the upper limit value of the compression pressure and the upper limit value of the compression duration based on the input from the remote controller RC. The upper limit values of the compression pressure and the

compression duration can be set only by a person such as a trainer who has a specific authorization.

The mode controller 90 is for controlling modes of the pressure muscle training method carried out by the pressure muscle strength increasing system. More specifically, the mode controller 90 chooses either one of the rehabilitation control mode and the training control mode as the mode of the pressure muscle training method based on the input from the operation section 58.

The image generator 98 is for generating the data about an image to be displayed on the display unit 57. The image generator 98 is designed to generate image data based on the data received from the pressure controller 60, the time interval controller 70, the limit value controller 80, and the mode controller 90.

The output controller 99 is for transmitting the data supplied from the pressure controller 60 and the time interval controller 70 to the motor I/F 54. These data are for controlling the motor. To sum up, the motor is controlled by the pressure controller 60 and the time interval controller 70 through the output controller 99 and the motor I/F 54.

Next, with reference to Fig. 7, how the pressure muscle strength increasing system is used is described.

In order to develop muscles using the pressure muscle strength increasing system of the present invention, the tight fitting band 1 of the muscle strength increasing device 10 is fitted around an upper portion of the muscles desired to be developed. Fig. 7 shows a state in which the tight fitting band 1 is fitted around an area near the proximal end of an arm. Fitting of the tight fitting band 1 around the area near the proximal end of the arm is performed for both arms in this embodiment.

Prior to fitting the tight fitting band 1 around the arms, the clip 12 is attached to the tube 5 at an arbitrary position along the length of it in this embodiment. When the tube 5 is longer than the circumference of the range to be compressed of limbs, one end of the tube 5 is overlapped with the other end when the tight fitting band 1 is fitted around the arm from the other end of the tube 5. Such overlapped portions of the tube 5 produce a gap between the tube 5 and the muscles, which may cause a trouble in that a compression pressure to be applied to the muscles by the tight fitting band 1 becomes improper. Thus, the clip 12 is attached to the tube 5 at an arbitrary position along the length of it to restrict the length of the tube 5 that is filled with the air, thereby avoiding a problem as described above. In other words, the clip 12 is attached as shown in Fig. 3B in this embodiment. Thus, the air can flow only into the portion of the tube 5 that corresponds to the circumferential length of the portion of the arm on which the tight fitting band 1 is worn. The air has no passage beyond that point.

To this end, the tube 5 is allowed to be removed from the tight fitting band 1.

Next, the tight fitting band 1 is fixed to the fixing unit 7 in such a manner that the diameter of a loop formed by the tight fitting band 1 does not change.

In this case, it is made carefully without producing any gap between the arm and the tight fitting band 1 because any gap between the arm and the tight fitting band 1 breaks the corresponding relationship between the air pressure to the tube 5 within the tight fitting band 1 and the compression force generated by the tight fitting band 1.

When the compression pressure control unit 20 is driven in this state, the tight fitting band 1 compresses the arm. With this, the wearer may either keep rest for a while in this state or do exercises using the muscles that he or she wants to develop in order to put a stress on the muscles. It is obvious that exercises provide a much better muscle development effect, but it has been found that a muscle development effect can be obtained even when the wearer keeps rest without any exercises.

When the compression pressure control unit 20 is driven, the air is supplied from the pump 2 controlled by the control mechanism 50 to the tube 5. At that time, the pump 2 is controlled according to the data generated by the control mechanism 50 for driving the pump 2 depending on the air pressure in the tube 5 that is monitored by the pressure gauge 3. This maintains the air pressure in the tube 5 at a suitable level, and the compression pressure applied by the tight fitting band 1 to the muscles is also maintained at a suitable level.

The segment of the air-receiving tube 5 of which boundary is defined by the clip 12 and which includes a portion connected to the connecting pipe 8a is inflated. In this case, the tube 5 is being inflated inwardly against the muscles and is also being inflated outwardly. The outside of the tube 5 is, however, limited by the limit piece 6. Thus, the direction of inflation of the tube 5 is limited to the inward direction against the muscles, as shown in Fig. 2. This results in an appropriate compression pressure being applied by the tight fitting band 1 to a predetermined range to be compressed on the limbs as the tube 5 is inflated.

When the muscle exercises are used, the connecting pipe 8a may get in the way. In such a case, a part of the connecting pipe

8a may be closed with a stopper 11 such as a clip to avoid leakage of the air from the tube 5 of the tight fitting band 1, and then the connecting pipe 8a and the T-shaped pipe 9 may be separated. The stopper 11 is used in this way when the training control mode described below is used. The aforementioned Fig. 7 shows a state where the stopper 11 is used to close the connecting pipe 8a.

Next, operations of the compression pressure control unit 20 is described. Fig. 8 shows an operation of the compression pressure control unit 20.

When the power is turned ON (S101) by using the ON/OFF switch for the power provided on the operation unit 58 of the compression pressure control unit 20, startup setting is configured (S102). In the startup setting configuration, the setting for the compression pressure control unit 20 at the time of the startup is displayed on the display unit 57. Then, the display unit 57 provides a prompt to ask the user which one of the diagnostic mode and the stand-by mode should be entered. After looking at the display, the wearer determines whether he or she takes the diagnostic mode or the stand-by mode. This choice is made by using the operation section 58.

More specifically, if the wearer chooses to take the diagnostic mode (S102: Yes) by using the operation section 58 within a predetermined period of time (e.g., within 10 seconds), then the process shifts to the diagnostic mode (S103). If the shift to the diagnostic mode is not selected (S102: No), then the process shifts to the stand-by mode (S105).

In the diagnostic mode, self-diagnosis is preformed to determine whether the compression pressure control unit 20 operates correctly. The diagnostic mode in this embodiment checks the

operation of the two pumps 2 for the right and left arms, the operation of the timer that measures time in the compression pressure control unit 20, and the operation of the pressure gauge 3.

After the beginning of the diagnosis, it is determined whether the diagnosis is completed (S104). If the diagnosis is not completed (S104: No), the diagnosis is continued. If the diagnosis is completed (S104: Yes), the process shifts to the stand-by mode (S105). This determination is repeated, for example, every 3 seconds.

Next, a process flow in the stand-by mode is described. Fig. 9 shows a flow diagram illustrating the process flow in the stand-by mode.

When the stand-by mode is entered (S1051), it is monitored whether the remote controller RC is connected to the aforementioned remote controller connector 58A (S1052). If the remote controller RC is connected (S1052: Yes), the process shifts to the trainer mode (S1053). If the remote controller RC is not connected (S1052: No), the process shifts to the user mode (S1054).

In the trainer mode (S1053), the maximum value of the compression pressure and the maximum value of the compression duration can be set that are used in practicing the pressure muscle training method. Input of these maximum values is made by using the remote controller RC. More specifically, the switch 111, which is provided on the remote controller RC, is used to enter the maximum value of the compression pressure and the maximum value of the compression duration that are used in practicing the pressure muscle training method carried out by the compression pressure control unit 20. To set these maximum values ensures the safety

during the practice of the pressure muscle training method. In situations where the remote controller RC is kept available for a trainer or a physician who has significant knowledge about the pressure muscle training method, the maximum value of the compression pressure and the maximum value of the compression duration can be set only by a person who has significant knowledge about the pressure muscle training method carried out by the compression pressure control unit 20. This further ensures the safety of the pressure muscle training method.

The data about the maximum value of the compression pressure that are supplied from the remote controller RC are sent to the limit value controller 80 through the operation section 58 and recorded thereon. The data about the maximum value of the compression duration are sent to the limit value controller 80 through the remote controller RC and recorded thereon. The trainer mode in this embodiment also allows to set the upper limit of the parameters that are described below. In this embodiment, different values may be set independently for the maximum values of the compression pressure for the right and left arms.

On the other hand, the following processing is executed in the user mode (S1054).

The wearer sets, by using the operation section 58, the maximum value of the compression pressure and the compression duration that are used in practicing the pressure muscle training method to the extent equal to or lower than the maximum value (critical compression pressure) determined in the aforementioned trainer mode and the maximum value (critical compression duration) determined in the aforementioned trainer mode, respectively.

In order to set the maximum value of the compression pressure,

the wearer turns a function selection switch of the operation section 58 to the "left" when it is for the muscle strength increasing device 10 for the left arm, and then presses the UP/DOWN button to change the maximum value of the compression pressure. The maximum value of the compression pressure during and after the setting is displayed on the display unit 57, so that the wearer can press the UP/DOWN button while looking at this. When the maximum value of the compression pressure displayed on the display unit 57 reaches a value that the wearer desires, the SET button on the operation section 58 is depressed to record that value. The data generated at that time are supplied to the pressure controller 60 to set the maximum value of the compression pressure. The numeric value displayed on the display unit 57 is controlled by the pressure controller 60 so that it does not exceed the maximum value of the compression pressure that is set in the aforementioned trainer mode. Therefore, the maximum value of the compression pressure that the wearer sets does not exceed the maximum value of the compression pressure that is set in the trainer mode. The maximum value of the compression pressure for the muscle strength increasing device 10 for the right arm may also be set in a similar manner. The maximum values of the compression pressure may be different between the muscle strength increasing devices 10 for the right and left arms.

In order to set the compression duration, the wearer moves the function selection switch of the operation section 58 to the timer and presses the UP/DOWN button to change the time interval. The compression duration during and after the setting is displayed on the display unit 57, so that the wearer can press the UP/DOWN button while looking at this. When the time interval displayed

on the display unit 57 reaches a value that the wearer desires, the SET button is depressed to record the value. The data generated at that time are supplied to the time interval controller 70 to set the compression duration. The time interval controller 70 performs control operation in order to avoid the numeric value displayed on the display unit 57 exceeding the maximum value of the compression duration that is set in the aforementioned trainer mode. Therefore, the compression duration that the wearer sets does not exceed the maximum value of the compression duration that is set in the trainer mode.

The trainer mode (S1053) and the user mode (S1054) are completed through the execution of the aforementioned processing. When exiting the trainer mode (S1053) or the user mode (S1054), the process enters the state to wait for the selection of the exit from the stand-by mode (S1055). If the exit from the stand-by mode is selected (S1055: Yes), the process exits the stand-by mode (S1056) and then enters the state to wait for the selection of the operation mode (S106). If the exit from the stand-by mode is not selected within a predetermined period of time (S1055: No), then the process returns to the state to enter the stand-by mode (S1051).

In the state of waiting for the selection of the operation mode (S106), if the operation mode is selected (S106: Yes), the process enters the operation mode (S107). If the operation mode does not selected (S106: No), the current status is maintained. The confirmation of presence or absence of the operation mode selection is repeated, for example, every 1 second.

In the operation mode, the pressure muscle training method is performed. More specifically, the pump 2 is driven and the air is supplied to the tube 5 of the tight fitting band 1 resting on

the arm of the wearer. As a result, the tight fitting band 1 applies a predetermined compression pressure to muscles of the wearer. The pump 2 automatically supplies the air while being controlled by the data generated by the time interval controller 70 to make the compression duration appropriate and also controlled by the data generated by the pressure controller 60 to make the compression pressure appropriate. In this state, the wearer carries out the pressure muscle training method.

When the operation mode is activated, it is monitored whether the operation mode is completed (S108). If the compression duration that the wearer has set elapses indicating that the operation mode is completed (S108: Yes), the process exists the operation mode. At that time, this compression pressure control unit 20 sounds a buzzer to notify the wearer of the completion of the operation mode. The wearer removes the tight fitting band 1 and finishes the pressure muscle training method. The wearer turns off the switch of the buzzer when he or she finishes the pressure muscle training method.

If the compression duration set by the wearer does not elapse, it is determined that the operation mode is not completed (S108: No). In such a case, the operation mode continues.

The control parameters that are used for the control by the aforementioned control mechanism 50 are described with reference to Figs. 10A and 10B.

In this embodiment, a common single timer count T is used for the right and left muscle strength increasing devices 10. The right pressure (the pressure applied to the right arm by the muscle strength increasing device 10 for the right arm) P_R and the left pressure (the pressure applied to the left arm by the muscle strength

increasing device 10 for the left arm) P_L are controlled independently. Illustrated in Fig. 10A is a conceptual relationship between the pressure P and the time T in the rehabilitation control mode. In this example, after the operation of the muscle strength increasing device 10 used for the right arm begins, the air pressure is increased to a preset pressure P_R at a predetermined rate. When the air pressure reaches P_R, the air pressure is kept at P_R for a preset time T. Then, the air pressure is returned to zero with buzzer sound. The muscle strength increasing device 10 used for the left arm operates similarly to the case of the muscle strength increasing device 10 for the right arm after a short delay from the muscle strength increasing device 10 for the right arm. The aforementioned P_R, P_L, and T are the parameters that the wearer can set. Details of the parameters are as shown in Fig. 10B.

Illustrated in Figs. 11A and 11B are compression sequences. In each figure shown in Figs. 11A and 11B, the ordinate and the abscissa as well as legends are similar to those shown in Figs. 10A and 10B.

In this embodiment, the compression sequences carried out in the aforementioned operation mode are the following two: the rehabilitation control mode and the training control mode. The wearer chooses one of them to use the operation mode. The selected mode is practiced in the operation mode.

Fig. 11A is a compression sequence used when the rehabilitation control mode is taken in the operation mode. In this rehabilitation control mode, after the operation of the muscle strength increasing device 10 used for the right arm begins, the air pressure is increased to a preset pressure P_R at a predetermined

rate. When the air pressure reaches P_R, the air pressure is kept at P_R for a preset time T. Then, the air pressure is returned to the atmospheric pressure after the elapse of the compression duration that the wearer has set. The muscle strength increasing device 10 used for the left arm operates similarly to the muscle strength increasing device 10 for the right arm after a delay from the muscle strength increasing device 10 for the right arm.

Fig. 11B is a compression sequence used when the training control mode is operated in the operation mode. In this training control mode, the pressure is not kept after the air pressure reaches P_R unlike the rehabilitation control mode. In this case, the wearer uses the stopper 11 to close the connecting pipe 8a that is connected to the muscle strength increasing device 10 at the time when the air pressure reaches P_R, and then does exercises while keeping the pressure within the tube 5. In this case, in the muscle strength increasing device 10 used for the left arm, the compression is performed in a similar manner to the muscle strength increasing device 10 for the right arm after a delay from the muscle strength increasing device 10 for the right arm. In this case, reduction in pressure by the control mechanism 50 does not occur but a buzzer sound is produced after the elapse of a predetermined time. Therefore, the wearer removes the stopper 11 from the connecting pipe 8a at the buzzer. This reduces the pressure in the tube 5.

Illustrated in Figs. 12A to 12E are sequences achieved when the RESET button is depressed in the operation mode. In each figure shown in Figs. 12A to 12E, the ordinate and the abscissa as well as legends are similar to those shown in Figs. 10A and 10B.

When the wearer depresses the RESET button during compression, temporal compression is stopped. The compression is restarted in

response to the depression of the START button (Figs. 12A and 12B). However, if the pressure does not reach a predetermined value (P_R, P_L) after the elapse of a predetermined time from the beginning of the compression, the pressure is reduced (Fig. 12C). When the RESET button is depressed before the pressure reaches the predetermined value (P_R, P_L), the measurement of the compression duration is restarted after the START button is depressed again (Figs. 12D and 12E).

Fig. 13 is a view illustrating which parameter can be designated (changed) at which stage in the operation mode.

The compression duration may be set anytime other than when one of the right arm and the left arm is compressed. In addition, the maximum value of the compression pressure may be set anytime other than when the right arm is compressed for the muscle strength increasing device 10 for the right arm and other than when the left arm is compressed for the muscle strength increasing device 10 for the left arm.

It should be noted that a wire-like piece 13 as shown in Figs. 14A and 14B may be used in place of the limit piece 6 of the muscle strength increasing device 10.

In this case, the fabric used on the side facing to muscles (inner side) of the tight fitting band 1 is made of stretch threads woven together to have a net-like appearance. The fabric used on the side opposite to muscles (outer side) is made from polyester foam. A plurality of plastic wire-like pieces 13 are provided therein generally in parallel to the widthwise direction of the tight fitting band 1 at a predetermined distance (5 mm to 1 cm) along the length of the tight fitting band 1, as shown in Figs. 14A and 14B.

The wire-like pieces 13 are described as being placed generally parallel to the widthwise direction of the tight fitting band 1 but they are not limited thereto. The wire-like pieces 13 may be any similar pieces that are provided in a direction not parallel to the lengthwise direction of the tight fitting band 1 at a predetermined distance along the length of the tight fitting band 1.

The wire-like pieces 13 in this embodiment are made of a plastic material but they are not limited thereto. They may be made of any other suitable material such as a metal or a resin.

The wire-like pieces 13 are illustrated as being embedded in the tight fitting band 1, but they are not limited thereto. They may be provided on the inner surface of the tight fitting band 1 during use and just outside the tube 5 during use.

For example, a plurality of wire-like pieces 13 may be placed on the inner surface of the tight fitting band 1 during use, generally in parallel to the widthwise direction of the tight fitting band 1 at a predetermined distance (5 mm to 1 cm) along the length of the tight fitting band 1. The wire-like pieces 13 may be fastened to the inner surface of the tight fitting band 1 during use, with a stretchable tape having a surface with an adhesive applied thereto.

With the wire-like pieces 13 provided as shown in Figs. 14A and 14B, the adjacent wire-like pieces 13 are spaced from each other at a predetermined distance. The portions that fall between the adjacent wire-like pieces 13 are not limited in their motion by the wire-like pieces 13. Thus, the muscle strength increasing device 10 can follow a complex up-and-down surface of the muscles. When a user does exercises with the tight fitting band being rest

on his or her body, the internal pressure within the tube 5 can be kept constant and a predetermined compression pressure can be applied more uniformly even under the influence of muscle movements.

Furthermore, the wire-like piece 13 that is used in the muscle strength increasing device 10 in place of the limit piece 6 may have a configuration as shown in Fig. 15. Fig. 15 is a cross-sectional view of an outer tight fitting band 1 during use. The wire-like piece 13 in this case is formed by bending a single wire-like piece. More specifically, the wire-like piece is formed by bending a single wire-like piece to put a series of angles in it and produce segments that are generally parallel to the widthwise direction of the tight fitting band 1 at a predetermined distance.

The requirement for the wire-like piece 13 is that it is formed to have a segment that is not parallel to the lengthwise direction of the tight fitting band 1. For example, a wire-like piece formed into a zigzag pattern like a continuous series of "V"s may be used.

This wire-like piece 13 may be embedded in the outer segment of the tight fitting band 1 during use or may be provided on the inner surface of the outer segment of the tight fitting band 1 during use and just outside the tube 5 during use.

The wire-like piece 13 in this embodiment is a single wire-like piece that is bent into meander. This eliminates the necessity of placing the wire-like pieces 13 at a certain distance along the direction generally parallel to the widthwise direction of the tight fitting band 1, as opposed to the case of the wire-like pieces 13 shown in Figs. 14A and 14B. Attachment to the tight fitting band 1 is easier.

With the wire-like piece 13 of the type described, the muscle

strength increasing device 10 can hold a complex up-and-down surface of the muscles in closer contact with it than the limit piece 6 can do. Therefore, this provides accurate control of the compression pressure.

In addition, in place of using the limit piece 6 or the wire-like piece 13, the tube 5 itself of the muscle strength increasing device 10 provides a configuration that allows the tube 35 to inflate inward as shown in Fig. 16. The requirement for the tube 35 is that the tube is designed to have a higher stretching rate on the side facing to the muscles than on the side opposite to the muscles, as determined with the tight fitting band 1 being rest on the muscles, and the tube 35 is also designed to inflate more in a direction against the muscles as the tube 35 is filled with air with the tight fitting band 1 being rest on the muscles.

For example, the tube 35 is made of a rubber. The part of the elastic body located on the side facing to the muscles is thinner than the part of the elastic body located on the side opposite to the muscles, as determined with the tight fitting band 1 being rest on the muscles.

In the muscle strength increasing device 10 having such the tube 35, the tube 35 inflates more on the thinner side, i.e., in a direction against the muscles as the tube 35 is filled with air. The pressure produced by the inflation of the tube 35 can be applied to the muscles without using the limit piece(s) or the wire-like piece(s), placing an appropriate compression force onto the muscles. This eliminates any means to limit the direction towards which the tube 35 is allowed to inflate, to inward.

In other words, muscle strength increasing device 10 can follow and hold a complex up-and-down surface of the muscles in

close contact with it in a flexible manner. When a user does exercises with the tight fitting band being rest on his or her body, the internal pressure within the tube 35 can be kept constant and a sufficient pressure can be applied to every part even under the influence of muscle movements. This eliminates any means to limit the direction towards which the tube 35 is allowed to inflate, to inward, providing a tight fitting band having a simple configuration.

Furthermore, as shown in Fig. 17, a tube 45 of the muscle strength increasing device 10 has a unique configuration. This tube 45 is a combination of two strip-shaped elastic bodies 45a and 45b having different stretching rates from each other, bonded along the sides thereof. The elastic body 45a located on the side facing to the muscles has a higher stretching rate than the elastic body 45b located on the side opposite to the muscles, as determined with the tight fitting band 1 being rest on the muscles.

The tube 45 configured as described above has a higher stretching rate on the side facing to the muscles than on the side opposite to the muscles, as determined with the tight fitting band 1 being rest on the muscles. The tube 45 inflates more in a direction against the muscles as the tube 45 is filled with air with the tight fitting band 1 being rest on the muscles.

In addition, as shown in Fig. 18, the tube 5 of the muscle strength increasing device 10 has a uniform stretching rate over the entire surface thereof. A stretchable seam tape 59 is adhered to it on the side opposite to the muscles. It is designed to have a higher stretching rate on the side facing to the muscles than on the side opposite to the muscles, as determined with the tight fitting band 1 being rest on the muscles.

The tube 5 configured as described above has a higher stretching rate on the side facing to the muscles than on the side opposite to the muscles, as determined with the tight fitting band 1 being rest on the muscles. The tube 5 inflates more in a direction against the muscles as the tube 5 is filled with air with the tight fitting band 1 being rest on the muscles.

<<Second Embodiment>>

Next, a second embodiment of the present invention is described.

The pressure muscle strength increasing system according to the second embodiment is generally similar to that of the first embodiment, and comprises a muscle strength increasing device 10 and a compression pressure control unit 20. The muscle strength increasing device 10 of the second embodiment has the same configuration as the one described in the first embodiment.

The compression pressure control unit 20 in the second embodiment is slightly different from the compression pressure control unit 20 in the first embodiment.

It is the fact that the compression pressure control unit 20 in the second embodiment has no remote controller RC nor remote controller connector 58A, and the critical compression pressure as well as the critical compression duration can be set with the compression pressure control unit 20 without using the remote controller RC. More specifically, in the compression pressure control unit 20 in this embodiment, any input to set the critical compression pressure and the critical compression duration is made by a person who has enough knowledge using the operation section 58 in a similar manner that the person who has enough knowledge

is performed in the trainer mode in the first embodiment.

However, the compression pressure control unit 20 in the second embodiment allows to set the critical compression pressure and the critical compression duration only when the below-described authentication is made.

In order to allow the aforementioned authentication, the operation panel 56 of the compression pressure control unit 20 in the second embodiment has a numeric keypad 58B as shown in Fig. 20. The numeric keypad 58B is for entering data for authentication. The compression pressure control unit 20 in the second embodiment is designed to receive the data that are used to set the critical compression pressure and the critical compression duration only when the data for authentication supplied through the numeric keypad 58B are correct. The means to enter the data for authentication is not limited to the numeric keypad 58B. It may be replaced with something that uses other characters such as alphabets.

In order to make the aforementioned authentication possible, the functional block generated within the control mechanism 50 when the CPU 51 in the compression pressure control unit 20 in the second embodiment executes a program is as shown in Fig. 21. That is, the functional block generated within the compression pressure control unit 20 in the second embodiment is a combination of the pressure controller 60, the time interval controller 70, the limit value controller 80, the mode controller 90, the image generator 98, and the output controller 99, as in the first embodiment, plus an authentication part N.

The authentication part N determines whether the data for authentication supplied by using the numeric keypad 58B are valid

or not and, if they are valid, then notifies the limit value controller 80 of it. The limit value controller 80 in this embodiment receives the data used to set the critical compression pressure and the critical compression duration from the operation section 58 only when the information indicating that the data for authentication is valid is received from the authentication part N.

How the pressure muscle strength increasing system in the second embodiment is used is basically similar to that in the first embodiment.

The compression pressure control unit 20 in the second embodiment operates as described in conjunction with the operation of the compression pressure control unit 20 in the first embodiment as shown in Fig. 8.

It should be noted that the compression pressure control unit 20 in the second embodiment operates in a slightly different manner from the compression pressure control unit 20 in the first embodiment when it is in the stand-by mode.

Fig. 22 shows a flow diagram illustrating a process flow in the stand-by mode carried out by the compression pressure control unit 20.

When the process enters the stand-by mode (S2051), it is monitored whether the numeric keypad 58B is operated (S2052). If the numeric keypad 58B is operated within a predetermined period time (S2052: Yes), then the process shifts to an authentication mode (S2053). If the numeric keypad 58B is not operated within the predetermined period of time (S2052: No), then the process shifts to the user mode (S2054).

In the authentication mode, validity of the data for

authentication supplied from the numeric keypad 58B is determined (S2055). The data for authentication are, but not limited to, entered as a combination of a combination of six numeric characters in this embodiment. In this embodiment, the data about the combination of the six-digit numerals entered by operating the numeric keypad 58B are supplied to the authentication part N. When the combination of the six-digit numerals matches with those contained in the authentication part N of the compression pressure control unit 20, the authentication part N determines that the data for authentication are valid (S2055: Yes). When the combination does not match, then it determines that the data for authentication are not valid (S2055: No).

If the data for authentication are determined to be valid, this information is sent to the limit value controller 80 to start the trainer mode (S2056). If the data for authentication are determined not to be valid, then the process shifts to the user mode (S2054). If the data for authentication are not valid, it may be allowed to enter the data for authentication three times for example.

In the trainer mode, as described above, the critical compression pressure and the critical compression duration are set. These setting may be made in a similar manner to the case where the critical compression pressure and the critical compression duration are set in the trainer mode according to the first embodiment. The data about the set critical compression pressure and critical compression duration are, as in the case of the first embodiment, recorded on the limit value controller 80.

On the other hand, in the user mode (S2054), the same processing as the one in the user mode (S1054) in the first

embodiment is executed.

The user mode (S2054) is completed through the execution of the aforementioned processing.

When exiting the trainer mode or the user mode, the process enters the state to wait for the selection of the exit from the stand-by mode (S2057). If the exit from the stand-by mode is selected (S2057: Yes), the process exits the stand-by mode (S2058) and then enters the state to wait for the selection of the operation mode, as in the case of the first embodiment. If the exit from the stand-by mode is not selected within a predetermined period of time (S2057: No), then the process returns to the state to enter the stand-by mode (S2051).

<<Third Embodiment>>

Next, a third embodiment of the present invention is described.

The pressure muscle strength increasing system according to the third embodiment is generally similar to that of the first embodiment, and comprises a muscle strength increasing device 10 and a compression pressure control unit 20. The muscle strength increasing device 10 of the third embodiment has the same configuration as the one described in the first embodiment.

The compression pressure control unit 20 in the third embodiment is slightly different from the compression pressure control unit 20 in the first embodiment.

It is the fact that the compression pressure control unit 20 in the third embodiment has no remote controller RC nor remote controller connector 58A, and the critical compression pressure as well as the critical compression duration can be set with the

compression pressure control unit 20 without using the remote controller RC, as in the case of the second embodiment. More specifically, in the compression pressure control unit 20 in this embodiment, any input to set the critical compression pressure and the critical compression duration is made by a person who has enough knowledge using the operation section 58 in a similar manner that the person who has enough knowledge is performed in the trainer mode in the first embodiment.

However, the compression pressure control unit 20 in the third embodiment allows to set the critical compression pressure and the critical compression duration only when the below-described authentication is made.

In order to allow the aforementioned authentication, the operation panel 56 of the compression pressure control unit 20 in the third embodiment has a card reader 58C in place of the remote controller connector 58A as shown in Fig. 23. The card reader 58C receives an IC card which is not shown and read the data for authentication recorded on the IC card. The compression pressure control unit 20 in the third embodiment is designed to receive the data that are used to set the critical compression pressure and the critical compression duration only when the data for authentication read through the card reader 58C are correct. The means for reading the data for authentication is determined depending on the type of the corresponding medium. It is not necessarily a device that can read the data from IC cards. For example, it may be replaced with a CD-ROM drive.

In order to make the aforementioned authentication possible, the functional block generated within the control mechanism 50 when the CPU 51 in the compression pressure control unit 20 in the third

embodiment executes a program includes the authentication part N that is similar to the one in the case of the second embodiment, as shown in Fig. 24.

The authentication part N determines whether the data for authentication read through the card reader 58C are valid or not and, if they are valid, then notifies the limit value controller 80 of it. The limit value controller 80 in this embodiment receives the data used to set the critical compression pressure and the critical compression duration from the operation section 58 only when the information indicating that the data for authentication is valid is received from the authentication part N.

How the pressure muscle strength increasing system in the third embodiment is used is basically similar to that in the first embodiment.

The compression pressure control unit 20 in the third embodiment operates as described in conjunction with the operation of the compression pressure control unit 20 in the first embodiment as shown in Fig. 8.

It should be noted that the compression pressure control unit 20 in the third embodiment operates in a slightly different manner from the compression pressure control unit 20 in the first embodiment when it is in the stand-by mode.

Fig. 25 shows a flow diagram illustrating a process flow in the stand-by mode carried out by the compression pressure control unit 20.

When the process enters the stand-by mode (S3051), it is monitored whether an IC card is inserted into the card reader 58C (S3052). If the IC card is inserted into the card reader 58C within a predetermined period of time (S3052: Yes), then the process shifts

to the authentication mode (S3053). If the IC card is not inserted into the card reader 58C within the predetermined period of time (S3052: No), then the process shifts to the user mode (S3054).

In the authentication mode, validity of the data for authentication read by the card reader 58C from the inserted IC card is determined (S3055). The data for authentication are, but not limited to, entered as a combination of a ten-digit alphanumeric characters in this embodiment. In this embodiment, the data about the combination of the ten-digit characters read from the IC card are supplied to the authentication part N. When the combination of the ten-digit characters matches with those contained in the authentication part N of the compression pressure control unit 20, the authentication part N determines that the data for authentication are valid (S3055: Yes). When the combination does not match, then it determines that the data for authentication are not valid (S3055: No).

If the data for authentication are determined to be valid, this information is sent to the limit value controller 80 to start the trainer mode (S3056). If the data for authentication are determined not to be valid, then the process shifts to the user mode (S3054). If the data for authentication are not valid, it may be allowed to enter the data for authentication three times for example.

In the trainer mode, as described above, the critical compression pressure and the critical compression duration are set. These setting may be made by similar operations to the case where the critical compression pressure and the critical compression duration are set in the trainer mode according to the first embodiment. The data about the set critical compression pressure

and critical compression duration are, as in the case of the first embodiment, recorded on the limit value controller 80.

On the other hand, in the user mode (S3054), the same processing as the one in the user mode (S1054) in the first embodiment is executed.

The user mode (S3054) is completed through the execution of the aforementioned processing.

When exiting the trainer mode or the user mode, the process enters the state to wait for the selection of the exit from the stand-by mode (S3057). If the exit from the stand-by mode is selected (S3057: Yes), the process exits the stand-by mode (S3058) and then enters the state to wait for the selection of the operation mode, as in the case of the first embodiment. If the exit from the stand-by mode is not selected within a predetermined period of time (S3057: No), then the process returns to the state to enter the stand-by mode (S3051).